How walkable is the city? Application of the Walking Suitability Index of the Territory (T-WSI) to the city of Rieti (Lazio Region, Central Italy)

Quanto è pedonale la città? Applicazione dell'indice di idoneità territoriale al cammino (T-WSI) alla città di Rieti

Daniela D'Alessandro,[1] Letizia Appolloni,[1] Lorenzo Capasso[2]
[1] Department of Civil Building and Environmental Engineering, "Sapienza" University of Rome
[2] Department of Public Health, Experimental and Forensic Medicine, University of Pavia
Corresponding author: Daniela D'Alessandro; daniela.dalessandro@uniroma1.it

SUMMARY

A method to evaluate the walkability of an urban neighbourhood based on direct observation has been applied.
This tool, called the Walking Suitability Index of the Territory (T-WSI), measures the walkability of every street of an environmental area. It includes 12 weighted indicators, each divided into 4 categories: practicability, safety, urbanity, and pleasantness. Each indicator can obtain one of the following values: excellent (100), good (75), poor (35), bad (0).
T-WSI is applied to 12/15 urban neighbourhoods of Rieti, a small city (47,912 inhabitants) located in Lazio Region (Central Italy).
The average of T-WSI scores range from 24.2 to 61.2 among urban neighbourhoods. On average, safety and urbanity are the categories which reach very low scores. The T-WSI allows to underline several street criticalities that could hinder walkability and could be a good basis to support public decision-makers about health policy and local development aimed at encouraging physical activity.

Keywords: walkability, indicators, neighbourhood

RIASSUNTO

È stato applicato un metodo atto a valutare la praticabilità pedonale di un quartiere urbano, basata sull'osservazione diretta.
Lo strumento, denominato indice di idoneità territoriale al cammino (T-WSI), misura la praticabilità pedonale delle strade di un quartiere. Comprende 12 indicatori ponderati, suddivisi in 4 categorie: viabilità, sicurezza, urbanità, piacevolezza. Ciascun indicatore può appartenere a una di queste categorie, con relativo punteggio: eccellente (100), buono (75), scarso (35), cattivo (0).
Nello studio il T-WSI è applicato a 12/15 quartieri di Rieti, una piccola città (47.912 abitanti) del Lazio.
I punteggi medi di T-WSI rilevati nei quartieri variano tra 24,2 e 61,2. In media, la sicurezza e l'urbanità sono le categorie che raggiungono punteggi molto bassi. Il T-WSI ha permesso di mettere in evidenza le criticità delle strade che potrebbero ostacolare la praticabilità pedonale. Pertanto potrebbe essere una buona base per supportare le amministrazioni pubbliche nel processo decisionale relativo alla politica di sviluppo locale per favorire l'attività fisica.

Parole chiave: praticabilità pedonale, indicatori, quartiere

INTRODUCTION

It is well established that built environment is a major health determinant[1,2] and urban neighbourhood features play a key role;[3,4] different aspects of public open space, such as access, size and design features, are associated with participation in physical activity. In particular, qualitative evidences show that safety, aesthetics, amenities, maintenance, and proximity of public open spaces are important attributes for supporting physical activity.[5,6]
Among the various characteristics of neighbourhoods that may impact on human health, one of the most important is walkability.[7,8] More walkable urban neighbourhoods are associated with increased physical activity, lower overweight, higher social interactions, lower prevalence of depression and reduced alcohol and drugs abuse.[9] Although the prevalence of inactivity differs between Countries, it appears to be the greatest modifiable risk factor for many non-communicable diseases (NCDs).[10-12]
Another challenge linked to sustainable mobility is the increasing urban traffic, which negatively interacts with health and quality of life because of the noise and air pollution, and also contributes to increase NCDs.[13,14] Therefore, the need for identification and validation of easy methods to evaluate the walkability of urban neighbourhoods is crucial in order to support Public Administrations in the decision-making processes related to health policy and local development.[15]
In the last twenty years, a relevant number of studies – even if not always strong and consistent – has been produced in the field of walkability and health,[12,16] providing an overall support for the associations between neighbourhood environment features and physical activity.[17-19]
The assessment of physical walking environment has been conducted using methods such as audits, tools, scales, instruments, checklists, inventories, levels of service, surveys, questionnaires, and indices.[20] The three methods which are most used to measure the walkability of a built environment are the followings:[19]

1. **self-reported measures** (interviews and questionnaires) to analyse how individuals perceive their surroundings, in particular in relation to the presence of different facili-

ties (commercial, educational, leisure, etc.)[19,21] that can be easily reached on foot.[20] These studies also assess factors influencing citizens' choices, such as quality of infrastructures, social environment, aesthetics of the neighbourhood, perceived safety,[5,22,23] but also the presence of green spaces, public lighting, cleanliness, etc;[24,25]

2. **walkability audits tools**, already used by advocacy groups to assess pedestrian facilities and to identify specific improvements that would make routes more attractive to pedestrians; although being simple and reliable measures, these tools are often unavailable because of the time required to collect them;

3. **measures arising from administrative archives**, often reworked with the geographic information systems (GIS) software,[12] come form archives data used to elaborate composite indices (for examples, the Walkability Index – WI – and the Walk Opportunities Index).[26-28] In particular, the use of advanced technology, such as the personal digital assistant (PDA), remote sensing, and GIS data, might help researchers to identify the relationships between built environment characteristics and walkability.[12] GIS data, for example, have the potential to be a useful public health tool, but are currently to a large extent unrealised.[12,14] Its use may introduce standardised measures that could evaluate different variables, thanks to the various operational definitions of the same built-environment measure which can report different characteristics in relationship to walking.[12]

It could be argued that these tools are mainly based on archival datasets, analysed with GIS, which do not consider the environmental quality of the context using a direct observation. In our opinion, direct observation can help to identify the physical factors (e.g., obstacles) that interfere with walkability, because they reduce the use of urban structures to some vulnerable groups, such as older people, people with disabilities, mothers with strollers, etc.

A detailed map of these physical factors could drive policy makers to invest in urban regeneration programmes aimed to reduce population inequalities in the access to physical activity practice.

In fact the biggest challenge is to integrate built-environment measures into public health surveillance and planning systems,[23] also orienting a regulatory framework, which is often inadequate.[29-31]

METHODS

To reach the aim of measuring the opportunities to perform physical activity in a urban neighbourhood, in particular walking, the authors used a tool called the Walking Suitability Index of the Territory (T-WSI).[19] This tool was already described in a previous paper, in which it was tested in two environmental area of Rome.[19] The present study developed the investigation using the T-WSI in Rieti, a small city of 47,912 inhabitants,[32] located in Lazio Region (Central Italy). Twelve neighbourhoods out of a total of 15 (80%) were selected, involving about 70% of the built surface of the town (figure 1). The selection criterion of neighbourhoods was the actual possibility to intervene on the roads in order to improve the usability for walking.

The T-WSI allows to measure walkability in each street of the considered urban neighbourhood. The assessment is based on 12 indicators, gathered in four categories of analysis:

1. **practicability** (C_P)**:** describes the real chance to practice the street, focusing on the difficulties caused by existing physical defects; this category includes the following three indicators: sidewalk surface, obstacles, road slope;
2. **safety** (C_S)**:** the protection against accidents that the road endowment provides; this category includes: protection from vehicles, road lighting, crossing protection;
3. **urbanity** (C_U)**:** it takes into account all the aspects concerning hospitality, comfort, attractiveness, vitality that a road can develop, according to the available facilities; this category includes: sidewalk width, road equipment, land mix, in terms of social and commercial activities, and amenities (e.g., shops, churches, post offices);[33]
4. **pleasantness** (C_G)**:** it concerns the sphere of welfare, considering that the subjective perception of environmental pleasantness may influence the choice of taking a walk; this category includes: vehicular traffic, building context, green space.[19]

A different weight is assigned to each category and to the included indicators, because of its impact on walkability.[19]

A value is assigned to each indicator according to a pre-arranged scale of merit, corresponding to a numerical rating scale (excellent=1, good=0.7, poor=0.35, bad=0.0). Before the study started, a multidisciplinary panel of experts had defined the criteria to attribute the answers to each level of the scale of merit.[19,34]

Data collected in each street have been inserted in an algorithm to perform weighted sums and to aggregate indicators and categories, according to percentiles and decimal coefficients, up to define the final index (final street index= $0.30*C_P + 0.25*C_S + 0.22*C_U + 0.23*C_G$).[19]

The neighbourhood index results as the sum of the weighted averages of each street indices, in which the length of each street is considered. Tables and radar diagrams have been used to present the results, expressed in centimetres for easier reading. GIS has been used for the cartographic data management.

During the investigation, a trained researcher collected data in each street using a structured evaluation grid to build up a database. Before inserting the definitive data

Figure 1. Map of the city of Rieti (Lazio Region, Central Italy). Coloured and numbered areas are the studied neighbourhoods.
Figura 1. Mappa della città di Rieti. I numeri e le campiture rosa indicano i quartieri indagati.

in this database, a quality control on data reliability was performed on a random sample of records by a different trained researcher, which independently re-collected the same data under the same experimental condition. Finally, the data were inserted into the algorithm to perform weighted sums and to aggregate indicators, up to define the final index. Average neighbourhood indices and indicators have been calculated and compared.

RESULTS

Table 1 shows the characteristics of the investigated environmental areas. The number which characterised every neighbourhood area corresponds to those shown in figure 1.

The twelve neighbourhoods differ from each other for age of construction and building characteristics.[35] Borgo S. Antonio, partly falling within the central historical section of the town, was built in the early 1950s as a residential area, characterised by in-line buildings, blocks of flats, and small villas, and completed by the end of the 1980s. The same constructing style characterises also the districts of Città Giardino, Fiume dei Nobili, Regina Pacis, and Molino della Salce, all defined as «middle-class neighbourhoods», and date back to the mid-1950s.

The districts of Quattro Strade, Fassini, and Villa Reatina are considered as working-class neighbourhoods: their construction begun during the fascist age (1920s-1940s), but they expanded in later years. They are mainly residential areas, characterised by low population density, and

NEIGHBOURHOOD	SURFACE m²	POPULATION* No.	AVERAGE POPULATION DENSITY inhabitants/km²
1. Borgo	210,383	1,849	8,788.7
2. Campoloniano	732,015	3,950	5,396.1
3. Città Giardino	124,408	1,375	11,052.3
4. Fassini	307,985	2,437	7,912.7
5. Fiume dei Nobili	119,400	824	6,901.2
6. Micioccoli	571,395	3,562	6,233.9
7. Molino della Salce	153,462	915	5,962.4
8. Piazza Tevere	273,879	1,765	6,444.5
9. Quattro strade	198,866	2,138	10,751.0
10. Regina Pacis	175,874	2,390	13,589.3
11. Viale dei Flavi	91,820	738	8,037.5
12. Villa Reatina	282,320	2,303	8,157.4
Total areas	3,241,807	24,246	7,479.2

*Source: Registry office of Rieti

Table 1. Characteristics of the studied neighbourhoods.
Tabella 1. Caratteristiche dei quartieri indagati.

NEIGHBOURHOOD	CATEGORIES				T-WSI
	PRACTICABILITY	SAFETY	URBANITY	PLEASURABLENESS	
1. Borgo	40.3	29.9	22.3	53.6	36.8
2. Campoloniano	65.8	26.3	35.1	72.0	50.6
3. Città Giardino	78.6	30.2	36.1	63.3	53.6
4. Fassini	56.5	24.6	31.0	85.3	49.5
5. Fiume dei Nobili	48.3	34.1	24.7	45.6	39.2
6. Micioccoli	58.1	52.2	51.2	58.3	55.2
7. Molino della Salce	78.4	35.8	34.1	46.8	50.8
8. Piazza Tevere	88.8	48.3	28.5	63.9	59.7
9. Quattro strade	67.2	12.5	13.2	61.9	40.5
10. Regina Pacis	70.2	37.2	38.7	64.6	53.7
11. Viale dei Flavi	87.6	31.9	45.1	73.8	61.2
12. Villa Reatina	16.9	8.0	21.4	54.1	24.2
% very poor scores (≤35)	8.3	66.7	58.3	0.0	8.3

Table 2. Scores of categories and T-WSI indexes, by neighbourhood.
Tabella 2. Punteggi delle categorie e indici di quartiere secondo il modello T-WSI.

NEIGHBOURHOOD	PRACTICABILITY			SAFETY			URBANITY			PLEASURABLENESS		
	SIDEWALK SURFACE	OBSTACLES	ROAD SLOPE	PROTECTION FROM VEHICLES	ROAD LIGHTING	CROSSING PROTECTION	SIDEWALK WIDTH	ROAD EQUIPMENT	LAND USE MIX	VEHICULAR TRAFFIC	BUILDING CONTEXT	GREEN SPACES
1. Borgo	29	21	67	12	59	21	8	14	44	62	71	26
2. Campoloniano	57	52	86	6	56	18	44	15	39	87	84	42
3. Città Giardino	66	71	98	12	27	47	41	28	37	63	73	54
4. Fassini	37	33	96	21	32	21	33	17	39	79	100	79
5. Fiume dei Nobili	38	28	75	16	28	54	20	7	45	45	81	11
6. Micioccoli	46	60	71	45	72	42	62	54	37	53	65	57
7. Molino della Salce	76	65	91	47	31	31	32	8	56	57	56	25
8. Piazza Tevere	85	92	91	31	40	69	24	16	42	68	88	34
9. Quattro strade	56	60	85	0	30	9	8	0	30	77	83	23
10. Regina Pacis	59	48	99	26	40	44	33	29	52	67	76	50
11. Viale dei Flavi	86	76	97	8	47	39	57	46	31	81	90	49
12. Villa Reatina	14	14	23	2	16	6	16	12	34	72	56	31
% very poor scores (≤35)	16.7	25.0	8.3	83.3	50.0	50.0	66.7	83.3	25.0	0.0	0.0	50.0

Table 3. Average scores for each indicator, by neighbourhood.
Tabella 3. Punteggi medi per ciascun indicatore, per quartiere.

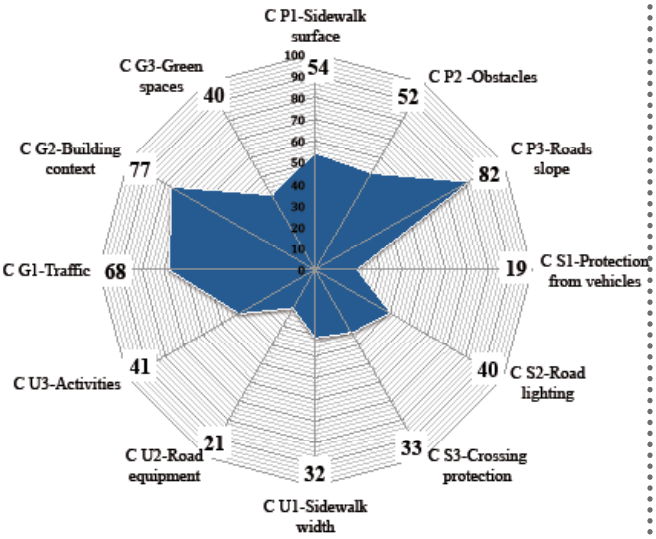

Figure 2. Average scores by indicator (aggregated data).
Figura 2. Punteggi medi per ogni indicatore (dati aggregati).

constituted partly by one- or two-family buildings (built from 1940 to 1965) and partly by 2-3 storey buildings (constructed between 1960s and 1990s).

The Micioccoli, Piazza Tevere, and Piazza Campoloniano neighbourhoods are considered peri-urban residential areas, dating back to the period between the 1960s and the 1990s. They are building-typology defined neighbourhoods with prevalence of in-line buildings and block of flats.

The neighbourhood called Viale dei Flavi, characterised by a high urban quality, is located in the first area of expansion between the historic city walls and the railway tracks. Its construction was started during the fascist age (1920s-1940s) and was concluded in the 1950s. This area is characterised by public buildings, small villas, courtyard houses, and blocks of flats.

The average T-WSI scores show a large variability among neighbourhoods, ranging from 24.2 of Villa Reatina, mainly characterised by a social housing, to 61.2 of Viale dei Flavi, consisting in prestigious building and located in a strategic area near the city centre, with offices, shops, etc. (table 2). Very poor T-WSI score is registered in 8.3% of neighbourhoods and only Viale dei Flavi met a sufficient T-WSI score (61.2). A large variability is registered both between and inside the categories. For example, in Villa Reatina the average score of each investigated category ranges from 8.0 («safety») to 54.1 («pleasantness») and, in the category «practicability», the scores range from 16.9 in Villa Reatina to 88.8 in Piazza Tevere. Overall, safety and urbanity obtained the lowest average scores, with the widest percentage of very poor scores of 66.7% and 58.3%, respectively (table 2).

Figure 2 shows the mean scores for each indicator by aggregating all neighbourhoods. On average, the indicators related to neighbourhood practicability (C_P) and pleasantness (C_G) show better scores; in particular, road slope obtained the highest score (82), showing a substantial absence of important drops on the investigated roads, with average slopes lower than 2%. In addition, building context and vehicular traffic reach the good scores of 77 and 68, respectively. These indicators are a matter of interest because they mean that, on average, neighbourhoods are made of small villas or other buildings with less than three floors and the traffic intensity is lower than 300 vehicles/hour. The availability of green spaces results insufficient: in fact, it appears to be discontinuous and minor, obtaining an average score of 40.

On average, safety (C_S) and urbanity (C_U) reach very low scores. In particular, the protection from vehicles and the equipment of roads are very poor, with scores of 19 and 21, respectively. These results express the complete absence of services on the road (e.g., benches, protected road section, speed dissuader). We found insufficient results also in crossings protection, sidewalks width, roads lighting, and mixed land use (activities), all factors that discourage active mobility.[15]

Table 3 shows in depth the average scores for each neighbourhood, supporting what has already been observed in the aggregate data. It is interesting that in 83.5% of neighbourhoods there is a lack of protection from road vehicles, in 66.7% the pavements are not wide enough, and in half of them roads lighting, crossings protection, and green spaces are very poor or completely absents.

CONCLUSION

The carried-out field investigation needs some comments. Although national and international entities suggest to perform regular physical activity to prevent NCDs,[10-15] it is difficult to put into effect this suggestion, particularly if the urban neighbourhood lacks of green areas, sports facilities or a context inviting to walk or cycling, like in Rieti. In fact, some attributes of the urban environment can make walking more comfortable: width of pavement, smoothness of walking surface, directness of routes, variety and attractiveness of views along the route, low levels of vehicular traffic, ease of street crossings, and absence of steps on the main walking route. Melbourne is an example of a city paying attention to these attributes: between 1993 and 2003, in its city centre it was observed a weekday increase of 39% in summer pedestrian traffic during working hours and 98% in the evenings.[15] Therefore, in a small city like Rieti, without vehicular traffic problems, the critical issues observed in this study would require the introduction of good practices, as already implemented in

other Italian cities or abroad; for examples 30 km/h zones, one-way streets, pedestrian zones, safe routes from home to school, etc.[19]

Furthermore, Jarrett et al.[36] estimated that the National Health Service could save about 17 billion pounds/year (1% of the National Health Fund) in 20 years if people walked 1.6 km each day, thanks to the reduction of the main diseases related to physical activity (type 2 diabetes, dementia, ischaemic heart disease, cerebrovascular disease, and cancer). Economic benefits resulted also in estimates performed in some Italian cities.[19] These relevant economic results should address policy makers toward choices aimed at improving neighbourhood environment, at least in terms of opportunity cost.

Finally, the fact that T-WSI is able to provide reliable data that well represent the real situation is a first-key betterment compared to other tools. The relevance of T-WSI, in fact, lies in the fact that the survey methodology, based on a direct and quite objective observation of the context. The method for data collection is easy and the same survey is carried out in a fairly short time, given the modest size (by definition) of environmental areas. Therefore, T-WSI resulted easy to use, very inexpensive, sensitive, and reproducible, offering a good base to measure walkability at neighbourhood level.

In the opinion of the authors, T-WSI could be a good support for decision-making of local health authorities and policy-makers, for the development of regeneration projects aimed to the redevelopment of urban voids or deteriorated areas of the cities.

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